CLAIMS

We claim:

- 1 1. A method of forming a high concentration borophosphosilicate glass layer on a
- 2 substrate, the method comprising:
- 3 providing a substrate in a chamber;
- 4 providing a silicon source, a oxygen source, a boron source and a phosphorous
- 5 source into the chamber to form a high concentration borophosphosilicate glass layer
- 6 on the substrate; and
- 7 reflowing the high concentration borophosphosilicate glass layer formed on the
- 8 substrate.
- 1 2. The method of claim 1 further comprising cooling the substrate for a
- 2 predetermined period of time following reflowing the high concentration
- 3 borophosphosilicate glass layer formed on the substrate.
- 1 3. The method of claim 1 wherein the high concentration borophosphosilicate
- 2 glass layer comprises about 2-7 weight percent boron and about 2-9 weight percent of
- 3 phosphorous.
- 1 4. The method of claim 1 wherein a combined weight percent of boron and
- 2 phosphorous present in the high concentration borophosphosilicate glass layer is about
- 3 10-12 weight percent.
- 1 5. The method of claim 1 wherein providing the silicon, oxygen, boron and
- 2 phosphorous sources into the chamber to form the high concentration
- 3 borophosphosilicate glass layer on the substrate is performed at a deposition
- 4 temperature in a range of approximately 300-600 °C.
- 1 6. The method of claim 1 wherein reflowing the high concentration
- 2 borophosphosilicate glass layer is performed at a reflow temperature in a range of
- 3 approximately 600-1050° C in an ambient selected from the group consisting of dry

- 4 ambient, steam ambient, water ambient and ambient formed by in-situ reaction of H₂
- 5 and O2.
- 1 7. The method of claim 1 wherein the silicon source is TEOS.
- 1 8. The method of claim 1 wherein the oxygen source is O_3 .
- 1 9. The method of claim 1 wherein the boron source comprises TEB.
- 1 10. The method of claim 1 wherein the phosphorous source comprises TEPO.
- 1 11. The method of claim 1 wherein the high concentration borophosphosilicate
- 2 glass layer fills at least one trench contained in the substrate having an aspect ratio of
- 3 about 7:1 to 10:1.
- 1 12. A method of forming an insulating layer on a substrate, the method comprising: 2 providing a substrate in a chamber;
- 3 providing a silicon source, a oxygen source, a boron source and a phosphorous
- 4 source to chemical vapor deposit a high concentration borophosphosilicate glass layer
- 5 on the substrate;
- 6 forming a second insulating glass layer of undoped silicon glass over the high
- 7 concentration borophosphosilicate glass layer; and
- 8 reflowing the deposited high concentration borophosphosilicate glass layer on
- 9 the substrate.
- 1 13. The method of claim 12 wherein the high concentration borophosphosilicate
- 2 glass layer comprises about 2-7 weight percent boron and about 2-9 weight percent of
- 3 phosphorous.
- 1 14. The method of claim 12 wherein a combined weight percent of boron and
- 2 phosphorous present in the high concentration borophosphosilicate glass layer is about
- 3 10-12 weight percent.
- 1 15. The method of claim 12 wherein reflowing the high concentration
- 2 borophosphosilicate glass layer is performed at a reflow temperature in a range of

- 3 approximately 600-1050° C in an ambient selected from the group consisting of dry
- 4 ambient, steam ambient, water ambient and ambient formed by in-situ reaction of H₂
- 5 and O₂.
- 1 16. The method of claim 1 wherein the silicon source is TEOS flowing in the
- 2 chamber at a rate of about 200-1000 milligrams per minute.
- 1 17. The method of claim 1 wherein the boron source is TEB flowing in the chamber
- 2 at a rate of about 100-300 milligrams per minute.
- 1 18. The method of claim 1 wherein the phosphorous source is TEPO flowing in the
- 2 chamber at a rate of about 10-150 milligrams per minute.
- 1 19. The method of claim 1 wherein the oxygen source is O₃ flowing in the chamber
- 2 at a rate of about 2000-6000 standard cubic centimeters per minute.
- 1 20. The method of claim 1 wherein the high concentration borophosphosilicate
- 2 glass layer is formed in the chamber at a rate in a range of approximately 2000 to 6000
- 3 Å/min.
- 1 21. The method of claim 12 wherein the second insulating glass layer has a
- 2 thickness in a range of approximately 100 to 200 Å.
- 1 22. A method of depositing an insulating layer on a substrate having at least one
- 2 trench, the method comprising:
- 3 chemical vapor depositing a high concentration borophosphosilicate glass layer
- 4 over the substrate by providing TEOS, O₃, TEB and TEPO into a chamber at a
- 5 deposition temperature of about 300° C. to 600° C. and a sub-atmospheric pressure of
- 6 about 60 to 750 torr, the high concentration borophosphosilicate glass layer comprising
- 7 less than or equal to about 7.0 weight percent boron and less than or equal to about 9.0
- 8 weight percent of phosphorous for a combined boron and phosphorous concentration of
- 9 about 10-12 weight percent; and

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reflowing the deposited high concentration borophosphosilicate glass layer at a
reflow temperature in a range of approximately 600° C to 1050° C to fill the at least
one trench in the substrate with the high concentration borophosphosilicate glass layer

- 1 23. The method of claim 22 wherein the at least one trench has a high aspect ratio 2 of about 4:1 to 10:1.
 - 24. A substrate processing system comprising:
- 2 a substrate holder located within a chamber;
- a gas delivery system to introduce a reactant gas mix into the chamber to
 deposit an insulating layer over the substrate;
 - a pump coupled to a gas outlet to control the chamber pressure;
 - a rapid thermal anneal system to reflow the layer deposited over the substrate;
 - a controller to control the gas delivery system and the pump, the controller further to control the rapid thermal anneal system; and
 - a memory coupled to the controller comprising a computer-readable medium having a computer-readable program embodied therein to direct operation of the substrate processing system, the computer-readable program comprising:

instructions to control the gas delivery system to introduce a reactant gas mix including a silicon source gas, a boron source gas, a phosphorous source gas and a carrier gas into the chamber to deposit a high concentration borophosphosilicate glass layer over the substrate positioned on the substrate holder, the instructions further to control a temperature of the reflow to enable the deposited high concentration borophosphosilicate glass layer to fill a trench in the substrate.

- 25. The substrate processing system of claim 24 wherein the high concentration
- 2 borophosphosilicate glass layer has a boron concentration in a range of approximately
- 3 2-7 weight percent and a phosphorus concentration in a range of approximately 2-9
- 4 weight percent for a combined boron and phosphorous concentration of about 10-12
- 5 weight percent.

- 1 26. The substrate processing system of claim 24 wherein the reflow is performed at
- 2 a reflow temperature in a range of approximately 600-1050° C in an ambient selected
- 3 from the group consisting of dry ambient, steam ambient, water ambient and ambient
- 4 formed by in-situ reaction of H₂ and O₂.
- 1 27. The substrate processing system of claim 24 wherein the trench has a high
- 2 aspect ratio of about 4:1 to 10:1.